Aircrew Mission Training via Distributed Simulation (MTDS) – Development of the Multi-Country Complex Synthetic Environment

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Recent military conflicts have been predominantly multinational in their execution. It has also been an environment involving the use of high technology systems against relatively rudimentary and widely dispersed enemy forces. The lack of well-defined enemy lines and infrastructures has mandated aerospace operations of an increasingly dynamic nature. In addition, due to the "CNN effect" the world is demanding minimal collateral damage. Because these missions involve a complex system of systems, numerous individuals and teams must interact with one another in order to plan and execute each mission. The training of the aerospace forces in this time-compressed, highly dynamic battlespace thus presents a major training challenge.

While teams may have developed high levels of expertise in team tasks within their particular specialties, cultures and nationalities, they may not have similar levels of expertise involving the inter-team tasks needed to effectively operate as part of a larger dynamic aerospace force. Furthermore, all teams at a national level have limited opportunities to train together in realistic, collective training environments.

One potential cost-effective solution to this training challenge is the use of Distributed Mission Training technologies to create a distributed virtual training environment in which the various teams and nations can collectively train together from home station in a common virtual environment.

This paper describes the technological aspects of Exercise First WAVE, a coalition force, Composite Air Operations (COMAO) mission training exercise using distributed simulation technologies being sponsored by the NATO SAS Panel Task Group 034. During this exercise, British, Canadian, Dutch, French, German, Italian and US aircrews, together with command and control personnel will plan, brief, execute, replay, and debrief composite force air missions using real-time simulators located in their home countries and interconnected via secure data links. The objectives of the project are to expand distributed simulation to intercontinental distances; develop systems to mitigate difficulties caused by extreme long distance links; establish processes for creating scenarios to fulfill specified training objectives; implement systems for distributed mission planning, briefing, and debriefing; and assess the effectiveness of distributed simulation for enhancing Warfighter skills in conducting coalition force operations.

Paper presented at the RTO HFM Symposium on "Advanced Technologies for Military Training", held in Genoa, Italy, 13-15 October 2003, and published in RTO-MP-HFM-101.

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **00 APR 2004**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE **Aircrew Mission Training via Distributed Simulation (MTDS) Development of the Multi-Country Complex Synthetic Environment**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Simulation Technologies, Inc Air Force Research Laboratory Bldg 558 Warfighter Training Research Division 6030 South Kent Street Mesa, Arizona 85212-6061 USA; Alenia Aeronautica S.p.A. LSIT Building 5 Box 18 Corso Marche, 41 10146 Torino ITALY**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001667, NATO RTO-MP-HFM-101 Advanced Technologies for Military Training (Technologies avancées pour lentraînement militaire)., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**18**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Keywords:

Mission Training, Distributed Simulation, Networked Training, Collective Training, Coalition Training, Complex Synthetic Environments, Virtual Simulation, Transoceanic Networks

1.0 INTRODUCTION

Mission Training via Distributed Simulation (MTDS) refers to several simulation resources, distributed over a geographically extended area, linked by a common network infrastructure. The primary use for such a distributed system as described in this paper is to conduct Composite Air Operations (COMAO), for training and/or mission rehearsal purposes. Of course the operations need not be restricted to the aeronautics domain: any type of resource can populate the distributed Synthetic Environment, thus including surface, sub-surface, ground and space entities as well.

Exercise First WAVE (EFW – Warfighter Alliance in a Virtual Environment) has been designed with the intent of demonstrating a NATO multi-national MTDS exercise, using HLA as the underlying architecture, the HLA FEDEP as a guiding development process, and existing legacy simulators as main actors, along with computer-generated forces (CGF). The entire project is being developed under the auspices of NATO through its Research and Technology Office and the Studies, Analysis and Simulation (SAS) Panel and NATO Modeling and Simulation Group (MSG), as shown in figure 1. The MTDS demonstration, First WAVE, is the deliverable for the joint task group effort.

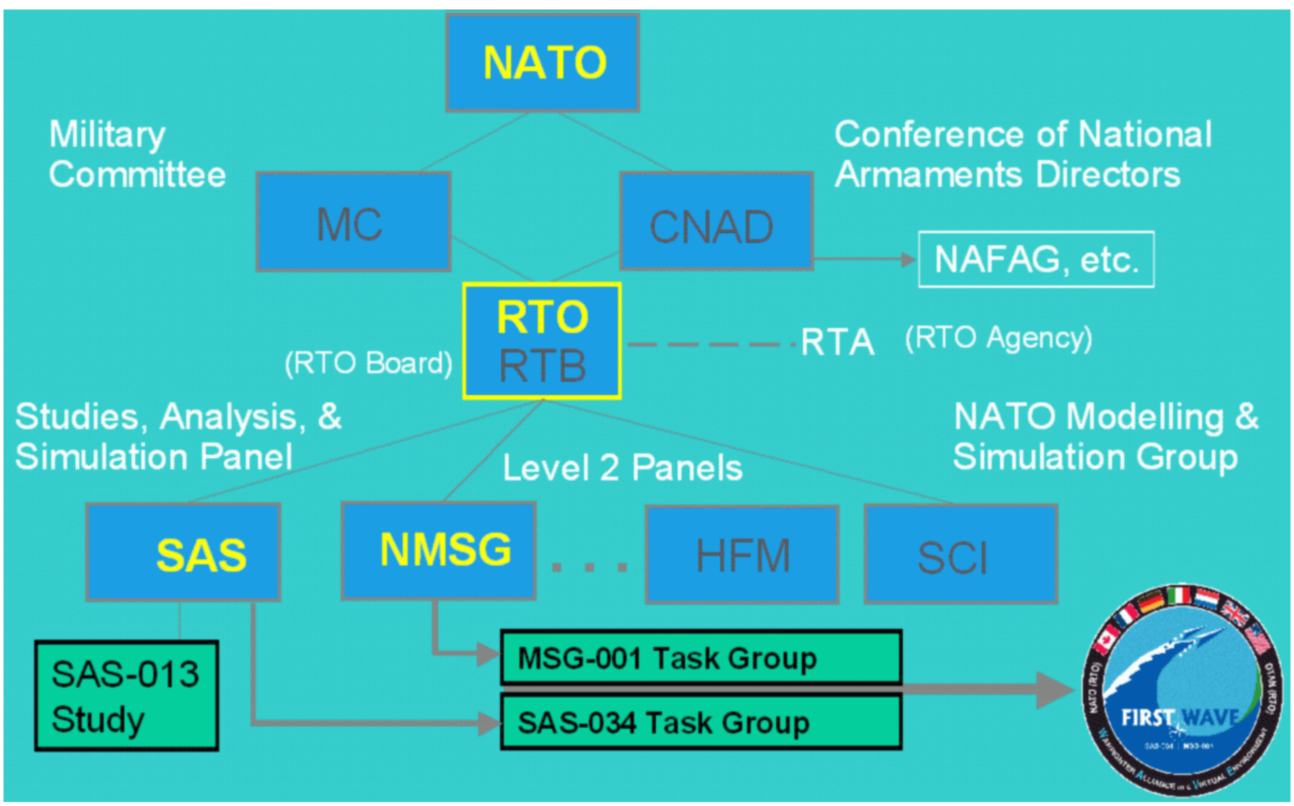


Figure 1: Position of the Task Groups within the NATO Structure.

Assessment of the feasibility, repeatability, and training value of NATO MTDS will be part of the final result, available some time after the demonstration which is currently scheduled for the third week of September 2004. Additional analysis will be devoted to the exploration and resolution of security concerns and challenges (the classification will be NATO Secret releasable to the participating nations only, namely Canada, France, Germany, Italy, The Netherlands, United Kingdom, and the United States), exercise management, and the performance and realistic behavior of CGFs as perceived by the pilots.

This paper describes the basic components of EFW and the technical challenges that have been tackled so far. Since it is still a "work in progress", some of the information herein presented is subject to change before the final demonstration. For a less technical overview of the same project, which also takes into account previous studies and NATO activities (such as SAS-013), please refer to "Aircrew Mission Training via Distributed Simulation – Progress in NATO", session V, paper number 16, by B. Tomlinson and J. van Geest.

2.0 THE EXERCISE

During the first 15 months of its existence, the First WAVE group operated as a main task group (Steering Committee) with five task teams (see figure 2). Each of the Task Teams has its own, domain-specific objectives, and documents have been produced to provide more detail regarding the Technical, Security and Assessment Teams objectives.

- **SAS-034 Task Group:**
  - Chairman, Barry Tomlinson (QinetiQ UK)
- **The five Task Teams within the Task Group:**
  - **Operations & Training Task Team**
    - Chairman: Capt Lee Gibbard (DND CA)
  - **Technical Task Team**
    - Chairman: Dave Greschke (AFRL US)
  - **Security Task Team**
    - Chairman: Lt Col Bob Jones (DND CA)
  - **Assessment Task Team**
    - Chairman: Dr. Herb Bell (AFRL US)
  - **Public Relations/Awareness Task Team**
    - Chairman: Barry Tomlinson (QinetiQ UK)

Figure 2: The SAS-034 Task Team Structure.

In September 2002 the United States announced it would fund the hiring of a First WAVE Project Manager to oversee the "big picture" and the project management plan which had been written. The key to success will be the test and integration plan, which was originally planned for a 12 to 18 month period. Communication costs, and the momentum experienced in most government budgeting processes, has led to the point that the real testing plan will be nine months for some countries and sites, and six months for others. These conditions are about the minimal time frame that can be reasonably tolerated without jeopardizing EFW, scheduled to run in September 2004.

In this section, the objectives of EFW are described, and the exercise mission illustrated.

2.1 The Objectives

The overall objectives of exercise First WAVE are:

- To investigate and assess the potential of MTDS to enhance aircrew mission readiness for NATO coalition operations, including consideration of training, simulation technology and management aspects
- To increase awareness of MTDS capabilities amongst national and NATO military staffs
- To capture experiences and lessons that will influence the future direction of the NATO MTDS program.

In addition to these overall objectives, there are specific national objectives. It will be the goal of the MTDS design for Exercise First WAVE to satisfy objectives at a multi-national or "alliance" level. However, while there is consensus of opinion in the overarching exercise objectives, it is anticipated that training and research objectives may vary according to the different national imperatives into synthetic mission training. National representatives of the SAS-034 and MSG-001 Task Groups may, therefore, wish to assess the Exercise according to their own National training and research criteria. The latter assessment processes are not summarized in this paper.

The overall objectives have been broken down into Training Objectives and Technical Objectives, which translate into the corresponding requirements. To the maximum extent possible, the following training objectives will be used as a basis of assessing the training utility of the MTDS demonstration:

- To practice daytime COMAO procedures employing fighter escort/sweep, AAR, SEAD, RECCE and AEW in a hostile EW environment
- To exercise procedures for defensive operations with Fighter Areas of Responsibility (FAORs) and point defense tasking
- To employ EW resources in support of offensive and defensive air operations
- To plan and integrate a multi-national COMAO in a defined threat environment
- To brief a COMAO package generated from dispersed locations
- To conduct mission debriefs
- To engender efficient team-working skills between Nations and differing elements of the COMAO package
- To develop a tactical appreciation of real-world threats
- To expose aircrew to situations to which they would not normally encounter in a peacetime environment
- To establish lessons identified.

Exercise First WAVE will also be used to facilitate investigation into a number of key areas.

1) Exercise Management, focusing on scenario development, process and strategy, tools, monitoring, control and analysis of mission critical events, and management of a distributed coalition exercise involving multiple sites
2) Interoperability, focusing on database requirements, utility of secure WAN, security policy, procedures, systems, federation design and integration process, standards, tools, voice communications, database exchange and re-use
3) Computer Generated Forces, focusing on their credibility, control, portability, and flexibility.

The technical objectives which had to be considered throughout the life of the project can be summarized as follows:

- Expand distributed simulation to intercontinental distances
- Develop systems, devices and procedures to mitigate difficulties caused by extreme long distance links
- Establish processes for creating scenarios that fulfill specified training objectives
- Implement systems for distributed mission planning, briefing, and debriefing
- Assess the effectiveness of distributed simulation with respect to enhancement of Warfighter skills in conducting coalition force operations.

It was recognized and agreed upon early in the planning that the First WAVE infrastructure would consist of devices of varying fidelity. The major reason was that there is no external source of funding other than each nation's contribution, so it was agreed that legacy simulators were going to be accepted "as is". As a consequence, a mix of full field of regard, high fidelity cockpit simulators will have to interoperate with single channel visual part task trainers, for instance. This is not the most ideal situation, but corresponds to the real world situation which needs to be taken into account. After reaching this agreement, the scenario was designed to accommodate the capabilities of the simulators used by each country. The only strictly necessary requirement was that all simulators participating had to be capable of maintaining real time. It must be finally pointed out that the proof that legacy resources can be successfully reused in a distributed simulation is an added value in itself.

2.2 The Mission

Air missions in a NATO context now focus extensively on operations where 20 to 40 or more aircraft fly in a package to strike a specific target or a set of targets. The composition of any package is based on the type of target, the expected threat during the mission and the level of destruction desired on the target.

Such a mission is referred to as a Composite Air Operation. COMAOs are defined as "operations interrelated and/or limited in both time-scale and space, where units differing in type and/or role are put under the control of a single commander to achieve a common, specific objective". In this context, some typical roles are: Strike Attack, Air Defense, Offensive Support and Reconnaissance. Support roles include Airborne Early Warning, Electronic Warfare and Air-Air Refueling. A COMAO package will comprise aircraft in defined formations performing specified roles. A specific COMAO may also be referred to as a mission. Successful participation in a COMAO requires that aircrews be prepared to participate as effective members of a multi-national force: these aircrews must be trained to operate as part of a collective combined force involving two or more teams from two or more countries. To meet this requirement, aircrews must master the skills necessary not only to employ their individual weapons systems but also master a number of collective or inter-team skills involving communication, co-ordination, planning, decision making, and situation assessment that will be exercised in a complex multinational environment.

COMAO training focuses on collective skills, and collective training is therefore defined as "training involving two or more teams, where each team fulfils different roles, training (to interoperate) in an environment defined by a common set of training objectives".

Exercise First WAVE has been designed to demonstrate the potential of MTDS throughout an end-to-end COMAO involving the following four phases: planning (including brainstorming), briefing, flying and debriefing. Activities designed to provide planning, briefing and debriefing activities are discussed below, while an illustration of the strike package air operations is summarily presented later.

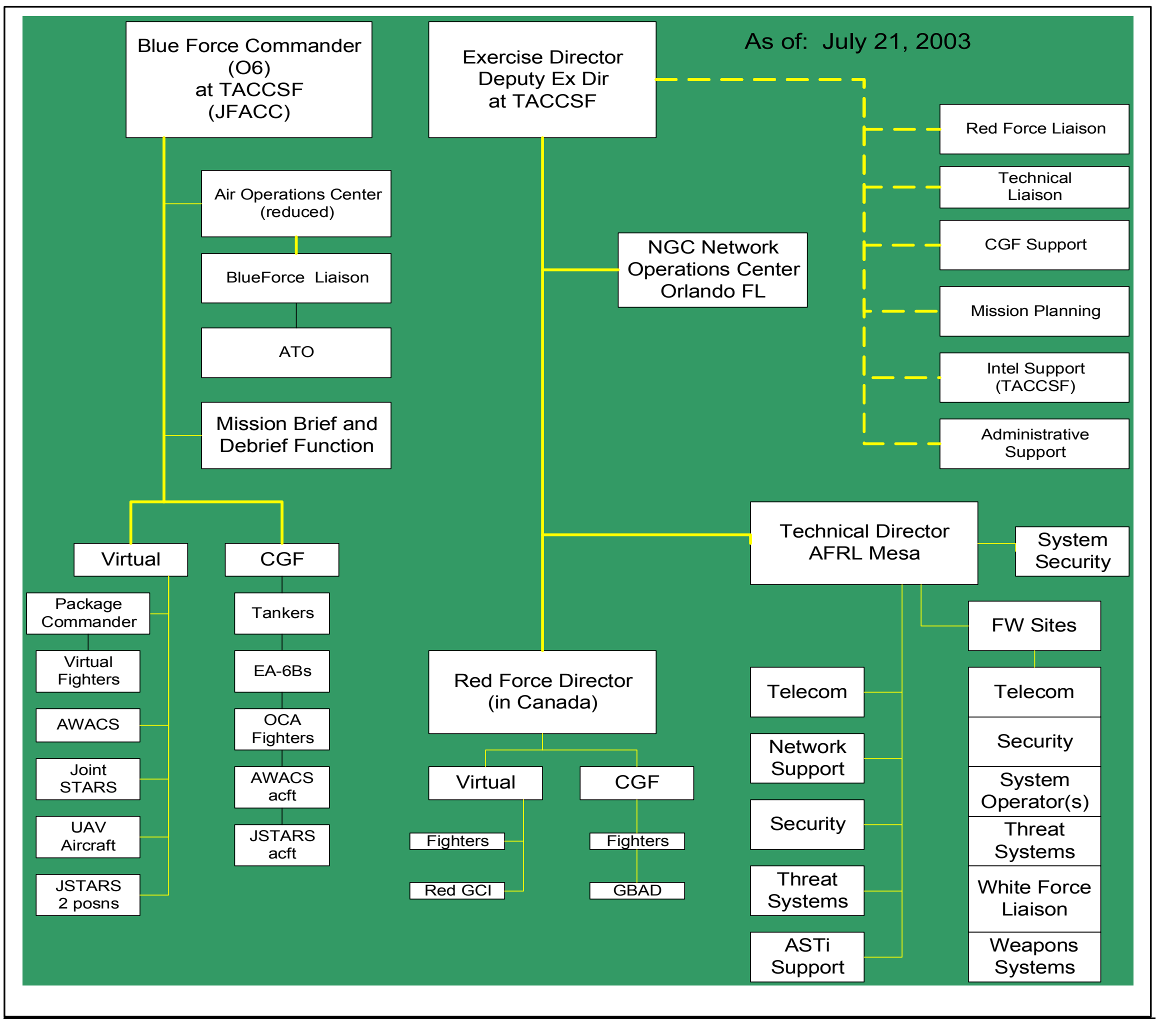


Figure 3: Functional Layout of the Overall First WAVE Execution Management.

A Typical COMAO mission starts when the Air Tasking Order (ATO) is first received. The ATO provides some very detailed information including Mission aim, package composition (i.e. the number and type of aircraft), weapons loads, target details etc. The ATO also specifies who the Mission Commander (MC) will be. Although the ATO is normally issued 8 to 10 hours before it is implemented, for Exercise First WAVE the ATO will be issued at the beginning of each mission day. Once the ATO has been 'broken out' by the MC, the MC will form a brainstorming and planning team to plan and co-ordinate the mission, having first received weather ("Met") brief, and an intelligence update.

Planning starts with the analysis of the target (type, location, and desired effects), taking into account the weather and the likely threats to be encountered *en route* and in the target area. The MC, assisted by his planning team, will formulate an attack plan. This plan will give due consideration to the package composition, DMPIs (Designated Mean Points of Impact) weapons, individual TOTs, package flow, ingress and egress routes, code words, and so on. Particular attention will be made to deconfliction plans.

The MC will also co-ordinate all other package elements such as electronic protection, SEAD (Suppression of Enemy Air Defense), fighter protection, and reconnaissance. This will include the overall routing, the overall package flow, the fighter sweeps and CAP (Combat Air Patrol), the RAI (Reconnaissance - Attack Interface), the AAR (Air-to-Air Refueling) plan, the AWACS plan, pre-strike holding and so on.

The Air Tasking Orders will be produced in advance by the Mission Planner. The blue force aircrews will be given additional information (intelligence, safety, weather, SPINS) to enable them to plan and brief. Facilities and equipment should be available to the aircrew at all nodes, to enable them to plan and brief.

For debrief, the ability to fully reconstruct the mission, enabling replay of any mission event, is desired. However, debrief capabilities will be a local responsibility at each of the nodes. The debrief will be led by the Mission Commander and must be accessible to MTDS participants at all sites. A synchronized mission play-back capability is planned for each site. Use of SmartBoard and VTC equipment is desired at as many sites as is possible in order to promote aircrew and White Force interaction. This will also facilitate a more effective debriefing and lessons learned session.

The map in figure 4 (yellow dashed outline) shows the gaming area, while figure 5 shows an overall view of the battle plan with friendly forces based in Italy and red air and ground forces scattered throughout the game area. Air refueling tracks and rendezvous airspace have been designated as shown in the same figure; the north and south edges of the battle area contain the orbits for high value assets such as the Joint STARS and AWACS aircraft. The blue forces comprise a mix of boom and hose/drogue air refueling tankers, as can be seen from figure 6. Blue Forces will be based in and will take off from four different bases in Italy, the only exception being a pre-positioned Forward Air Controller operated by The Netherlands, which will be in the target area on the ground at time zero. The First WAVE Strike Package configuration following the air refueling and rendezvous phases is shown in figure 8. The mission will unfold from this point on, based on real-time actions and interactions, according to their own flight plans. An example of ground targets is shown in figure 9 (targets 13, 14, 15 and 16), consisting of fuel storage tanks. Figure 10 shows targets 17 through 20, which are a series of building complexes.

The approximate locations of on-station assets are shown in figure 7.

Figure 4: First WAVE Gaming Area (yellow dashed box).

Figure 5: Overall View of the Battle Plan.

Air-Air Refueling TANKERS - BOOM
- 2 x KC-10 (*KILO CHARLIE 12)*
- 2 x KC-10 (*KILO DELTA 23)*
- 1 x KC-10 (*KILO GOLF 14*)

Air-Air Refueling TANKERS - HOSE/DROGUE
- 2 x KC-10 (*KILO ECHO 33)*
- 2 x KC-10 (*KILO FOXTROT 25)*
- 1 x KC-10 (*KILO HOTEL 15*)

BRINDISI / CASALE AIRBASE
- F-15C (*STEIN 61*) TACCSF
- F-15C (*GHOST 71*) EGLIN
- F-16C (*VIPER 41*) MESA

LECCE / GALATINA AIRBASE
- UAV (*SPECTRUM 05*) TACCSF
- EFA (*CANNON 31*) GE / IT
- M2000C (*VOXAN 11*) FR

GIOIA DEL COLLE
- GR4 (*SILVER 21*) UK
- GR4 (SAF)
- CF-18A (*COBRA 33*) CA
- F-16MLU (*LOTUS 50*) NL

BARI / PALESE
- F-16CJ (*ADAMS 45)* SHAW
- EA-6B (*COMANCHE 77*)

IN Pristina TARGET AREA
- FAC (*WINDMILL*) NL

Note: Red entries are CGFs

Figure 6: List of the Blue Forces.

AWACS / JSTARS in ORBITS

BOSNIA
- E-3C (*BADGER 01)* TACCSF
- F-15C (*GHOST 13*)

ALBANIA
- E-3C (*DISCO 02*)
- E-8 JSTARS (*BIGTOE 35)* TACCSF
- M2000C (*VOXAN 35*)

AAR TRACKS

NORTH
- KC-10 / BOOM (*KG 14*)

CENTRE
- KC-10 / BOOM (*KC 12*)
- KC-10 / BOOM (*KD 23*)
- KC-10 / HD (*KE 33*)
- KC-10 / HD (*KF 25*)

SOUTH
- KC-10 /HD (*KH 15*)

Note: Red entries are CGFs

Figure 7: On-Station Assets.

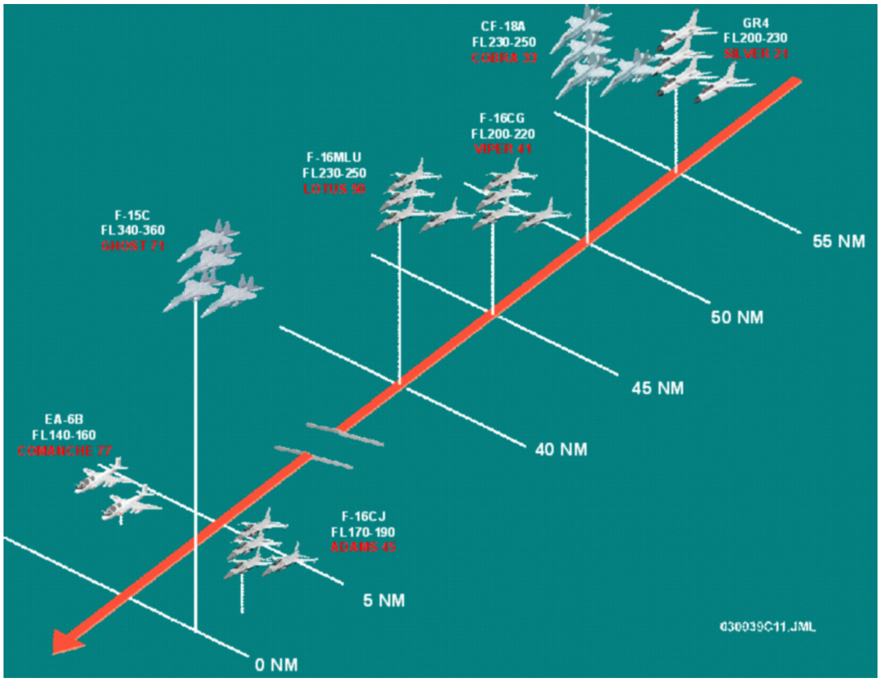


Figure 8: Strike Package Configuration.

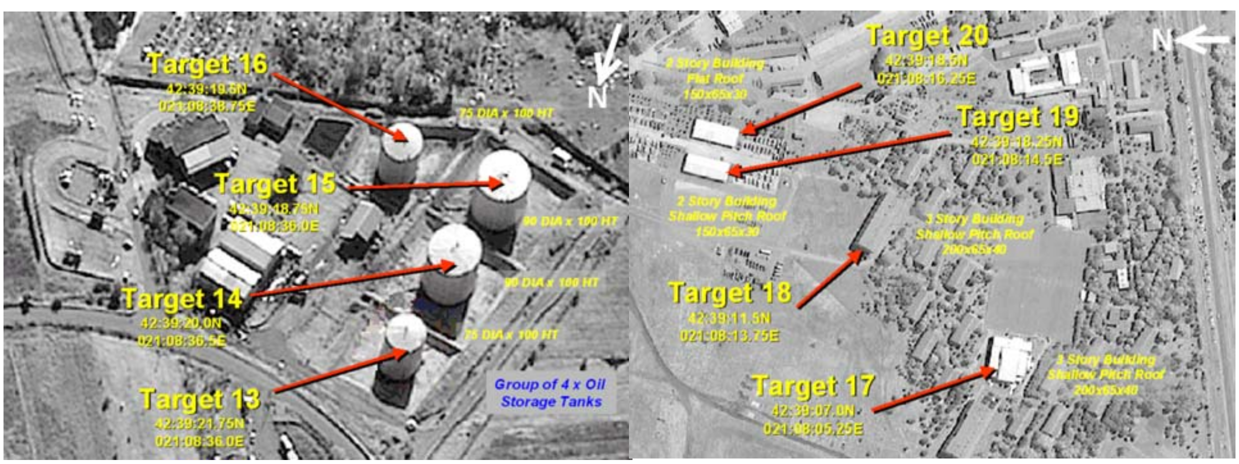


Figure 9 and 10: Example of Target Sets in the High Resolution Area.

Originally a traditional approach to the White Force was anticipated, with all of the required functions located in one place. The plan was revised when Canada requested to manage the entire Red Force and treat it as a blue force exercise from their point of view. Under these conditions, it was agreed to move the Red Force Director function to Canada and move the remaining functions to the Theater Air Command and Control Simulation Facility (TACCSF), located at Kirtland AFB New Mexico (USA). This change was accepted since it maximizes the training benefits for everyone. The only requirement of the "Red Force" execution is to remain subordinate to the real Blue Force Training objectives during First WAVE. The diagram in figure 3 shows the functional layout of the White Force and the overall First WAVE execution management.

The enemy Integrated Air Defense system will be structured as shown in figure 11, its key features being several air bases, fixed and mobile radar and missile sites. The specific force composition includes MiG-29Bs, MiG-21 2000 and MiG-21bis, SA-3 and SA-6. Five enemy air bases will be under the control of the Red Force Director.

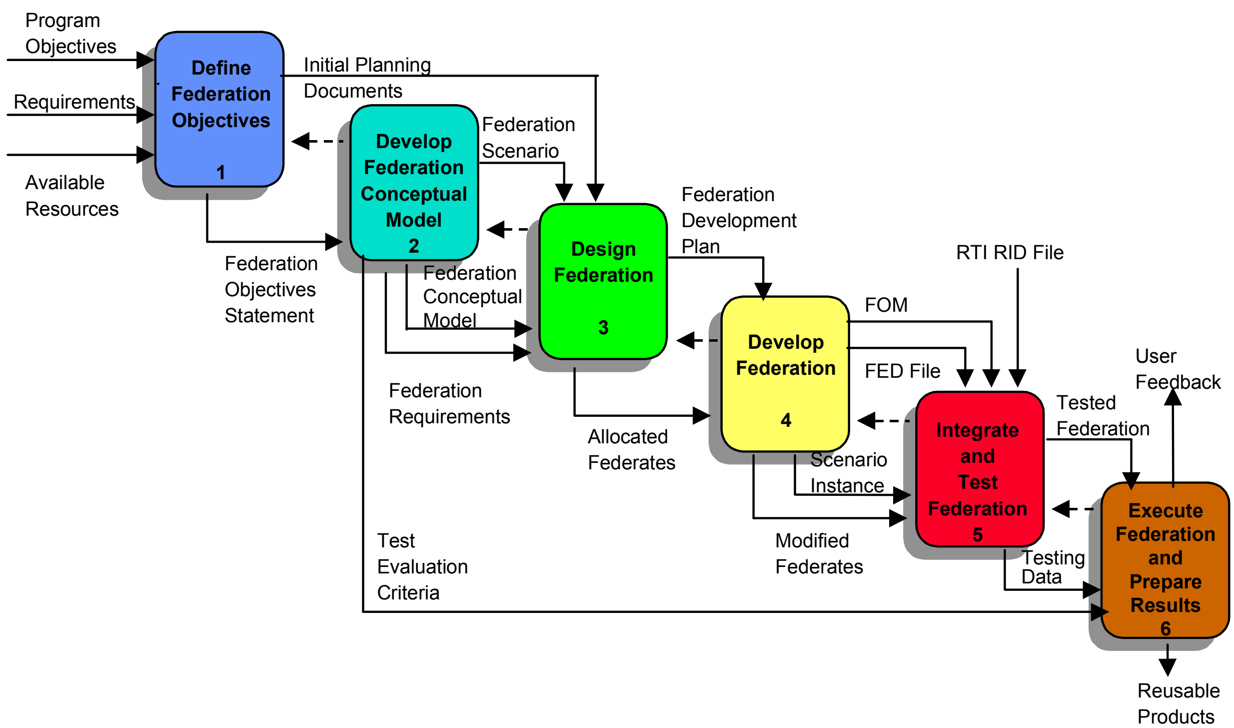
Figure 11: "Notional FW Enemy" IADS.

2.3 The Federation Execution and Development Process

The connection between all simulation resources adheres to the High Level Architecture standard (HLA), which will be described in section 3.2. This architecture specifies a development and execution process called the FEDEP which has been used as the basis for planning throughout the First WAVE project.

When the initial definition of the High Level Architecture (HLA) was first made public in early 1995, a number of new concepts were introduced. One such concept was the notion of a federation, which was defined as a set of software applications capable of exchanging information based on an agreed upon interchange document known as a Federation Object Model (FOM) and brokered by a common federate communication interface referred to as the Runtime Infrastructure (RTI).

One of the design goals identified early in the development of the HLA was the need for a high degree of flexibility in the process by which HLA applications could be composed to achieve the objectives of particular applications. Because of this basic desire to avoid mandating unnecessary constraints on how HLA applications are constructed, it was recognized that the actual process used to develop and execute HLA federations could vary significantly within or across different user applications. For instance, the types and sequence of low-level activities required to develop analysis-oriented federations is likely to be quite different from those required to develop distributed training exercises. However, at a more abstract level, it is possible to identify a sequence of six very basic steps that all HLA federations will need to follow to develop and execute their federations: they are shown in figure 12, and briefly described below.



Step 1: Define Federation Objectives. The federation user and federation development team define and agree on a set of objectives and document what must be accomplished to achieve those objectives.

Step 2: Develop Federation Conceptual Model. Based on the characteristics of the problem space, an appropriate representation of the real world domain is developed.

Step 3: Design Federation. Federation participants (federates) are determined, and required functionalities are allocated to the federates.

Step 4: Develop Federation. The Federation Object Model (FOM) is developed, federate agreements on consistent databases/algorithms are established, and modifications to federates are implemented (as required).

Step 5: Integrate and Test Federation. All necessary federation implementation activities are performed, and testing is conducted to ensure that interoperability requirements are being met.

Step 6: Execute Federation and Prepare Results. The federation is executed, outputs are generated, and results are provided.

Since this six-step process can be implemented in many different ways depending on the nature of the application, it follows that the time and effort required to build an HLA federation can also vary significantly. For instance, it may take a federation development team several weeks to fully define the real world domain of interest for very large, complex applications. In smaller, relatively simple applications, the same activity could potentially be conducted in a day or less. Differences in the degree of formality desired in the development process can also lead to varying requirements for federation resources. It is the hope of the developers of First WAVE that the many hurdles encountered will be considerably easier to overcome if there is a "Second WAVE" and that it will be of benefit to capitalize on the results here achieved and left in place by First WAVE.

3.0 THE VIRTUAL ENVIRONMENT FOR FIRST WAVE

A significant technical challenge that appears whenever many different sites or several different versions of image generators are linked together to create a virtual environment is the problem of database correlation. The First WAVE common exercise area covers 48 geocells (one degree latitude by one degree longitude each), or about 173,000 square miles. The location of the gaming area for First WAVE, Kosovo, was chosen simply based on the fact that the database provided a manageable size for a database, the data for this region was readily available, and there was previous operational coalition experience which could possibly be compared to the virtual recreation of these previous military operations. The yellow outline on the map in figure 4 shows the overall extent of the database for First WAVE. It is rendered overall at 10-meter resolution. The targets sets (figures 9 and 10), all located within a 20-mile radius circle, are generally one-meter resolution insets.

The various sites employ, within their simulators, image generators manufactured by different vendors, with varying degrees of sophistication. Canada volunteered to produce the database in several different formats, compatible with the toolsets of the major image generators used. The formats provided were either Open Flight, for more modern image generators, or the entire collection of Geotiff and DTED files for those sites which had specific format requirements. Another US First WAVE industrial partner agreed to convert the First WAVE database to E&S formats for all of the existing E&S customers. Due to limited budget and engineering integration time, sensor databases and Link-16 implementation over the wide area network were eliminated from the requirement list.

In order to produce the computer-generated forces (CGF) necessary to support First WAVE, it was originally thought to use Joint SAF. Unfortunately it was quickly discovered that Joint SAF is not for export, and an alternative CGF environment had to be identified. A Canadian industrial partner volunteered to support First WAVE with a commercial product, for both generating the CGF environment during First WAVE and to support the development and integration of the Test Federate.

Figure 13 shows a diagram of what a typical laser-guided bomb attack might look like, shown here as an example of the detailed planning that had to go into designing the actual scenario to be used, to ensure that the scenario would be tactically relevant.

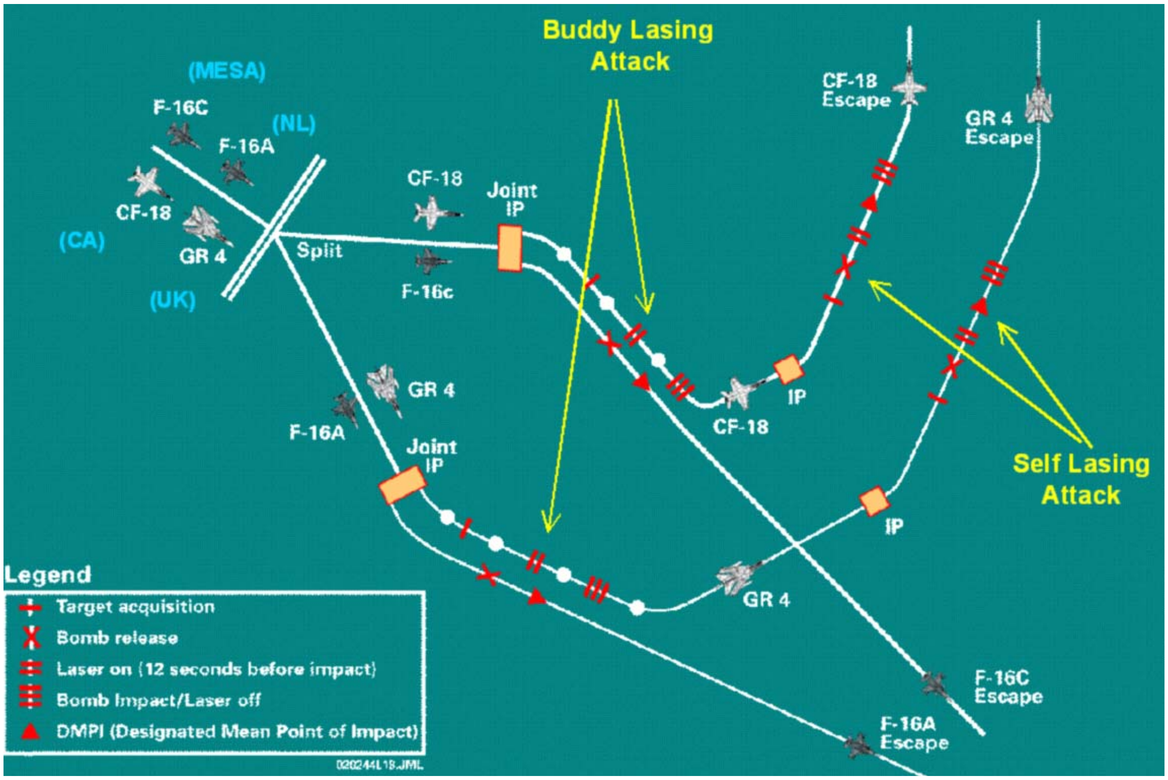


Figure 13: Sample Laser-Guided Bomb Attack.

During the definition phase of the technical objectives, the determination of the extent of the network itself, figuring out its physical size and the number of entities in the scenario were all critical factors that had to be taken into consideration in order to determine the best approach for the requirements on the physical network. This forced a tight cooperation among the Task Teams within First WAVE. On top of the physical network, software architecture had to be chosen, and the entire system will need to be accredited by the National Security Agencies in order to operate at the required classification level.

Presently, the seven countries that will participate in First WAVE are Canada, France, Germany, Italy, The Netherlands, United Kingdom, and the United States. The network will consist of 15 separate locations where manned simulators are present, in addition to the Network Operations Center (NOC) located in Orlando, Florida.

3.1 The Network

Issues of packet latency, capacity, quality of service and reliability had to be investigated. Most sites will also include a recording and playback software and hardware package called DCS (DMT Control Station), and provided free of charge by the Air Force Research Lab in Mesa, AZ. Voice communication will be taken care by the ASTi radio simulation environment during the actual flying time, and by specific videoconferencing equipment for briefing and debriefing.

Due to the physical size of the network and the predicted number of entities involved, a full mesh ATM backbone was chosen for First WAVE. The network activity and performance will be controlled by the

Network Operations Center (NOC) in Orlando, Florida. The network scheme (figure 14) includes what is known as the DMT Portal, which is a PC-based layer above and below an encryption device. The portal is the common interface among all sites, acting therefore as a gateway, whose configuration can only be controlled by the NOC.

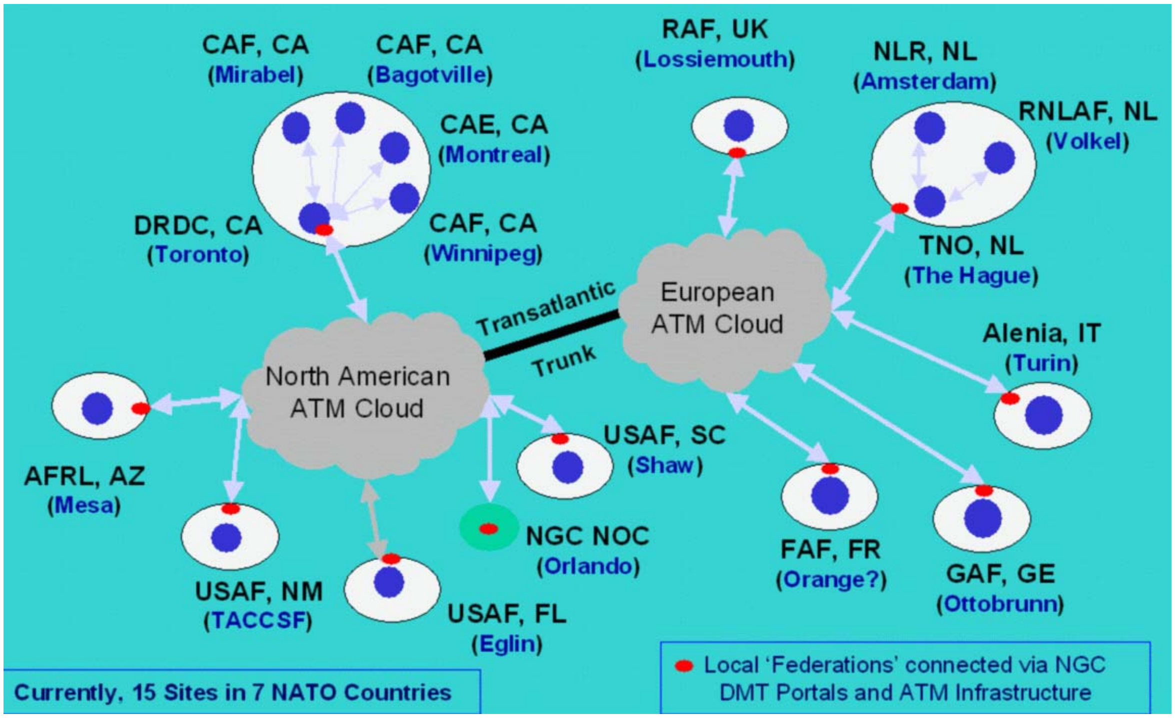


Figure 14: The Network Topology.

3.2 The Architecture

Several protocols can be used to shuffle data among networked sites. With a complex scenario, though, what really makes the difference between success and failure is a suitable architecture. Among all of the decisions that had to be made early in the process, one of the major ones was which interoperable protocol architecture to use. Even though the overall desire was to use High Level Architecture (HLA), it was decided to allow the use of both HLA and Distributed Interoperable Simulation (DIS). The overall categorization of First WAVE is an HLA exercise; however, since there was no external budget, those sites running DIS are allowed to participate. The sites with a native HLA solution are allowed to run HLA, and the DMT Portal will handle either case (HLA and DIS) and manage the communications over the long haul, thereby reducing the integration time needed for interoperability.

Most legacy flight simulators have been designed for stand-alone operation, principally aimed at skills development and maintenance. Typical MTDS applications require, on the contrary, a substantial level of interoperability and training at the team and teams-of-teams level. As a consequence, a considerable amount of optimization and integration is normally needed. The High Level Architecture was designed for such a project but there a still very few real-time networked simulators operating with a native HLA solution. Thus, First WAVE will support both protocols.

Within virtually all western nations, in particular the USA and the UK, there is a substantial effort to integrate and acquire HLA know-how, and to use it as a replacement for earlier DIS protocol. First WAVE will serve as a high fidelity, large scale proof-of-concept for fast jet real-time environments.

3.3 Security

From the very beginning, the Technical Task Team and the Operations and Training Team insisted that First WAVE be conducted at the SECRET level. The reason for this requirement was to maximize the training value of the entire project. A specifically designated sub-group began investigating whether or not there were any existing agreements already in place between participating nations that would make the approval process easier: none suitable were found.

The one existing agreement and corresponding network that looked promising for First WAVE is known as the Combined Forces Battle Lab (CFBL). The reason CFBL was not chosen is that some of the networks it comprises have too little bandwidth to support all the traffic that will be generated, in addition to the fact that First WAVE would not have had the priority it needs in 2004, due to JWID and JEFX, two major battlestaff exercises scheduled for mid-2004.

Current efforts are being made towards gaining accreditation from the Multinational Security Accreditation Board (MSAB). The current MSAB members are the USA, Canada, and the United Kingdom. Details are being worked out to include The Netherlands, Germany, France and Italy, and it seems that the final stamp of approval will be issued swiftly, once each nation approves the exercise according to its own security accreditation criteria.

The current classification of First WAVE remains "NATO SECRET – Releasable to CA, FR, GE, IT, NL, UK, US", and a joint Memorandum of Understanding (MoU) and Security Agreement is being worked on at this time.

4.0 CONCLUSIONS

The key benefits of First WAVE are several. Its primary characteristic is that it will most likely be the largest real-time, distributed, virtual exercise ever attempted. From Arizona to Italy, it will be working with probably the largest number of real-time HLA federates ever connected. This will enable testing of HLA in a very unique and demanding environment – fast jets within visual range of each other. The large area network will also provide excellent insight into the characteristics of transoceanic networks with regards to latency and stability issues.

First WAVE will serve as an excellent proof of concept and validation of global distributed mission operations in a training-on-demand coalition environment. It will leave behind valuable knowledge, a multinational training infrastructure, and will establish an important milestone in how to approach and hopefully solve the problems that need to be dealt with in such a complex endeavor.

5.0 LIST OF ACRONYMS

AFRL Air Force Research Laboratory

CEPA Common European Priority Area
CGA Computer Generated Actor
CGF Computer Generated Forces
CNAD Conference of National Armament Directors
COTS Commercial Off The Shelf

DERA Defense Evaluation and Research Agency
DIS Distributed Interactive Simulation
DMSO Defense Modeling and Simulation Office
DOD Department Of Defense
DTED Digital Terrain Elevation Data
DFAD Digital Feature Analysis Data

FLIR Forward Looking Infra-Red
FMS Full Mission Simulator
FOR Field Of Regard

HLA High Level Architecture
HMD Helmet/Head Mounted Display
HMI Human Machine Interface
HUD Head-up Display
HW Hardware

IEEE Institute of Electrical and Electronic Engineers
IR Infrared
ISDN Integrated Services Digital Network

LMA Locally Manned Aircraft

MC Military Committee
MIT Massachusetts Institute of Technology
MTDS Mission aircrew Training via Distributed Simulation

NVG Night Vision Goggles

PVI Pilot Vehicle Interface

RPV	Remotely Piloted Vehicle
RTA	RTO Agency
RTB	RTO Board
RTI	Run-Time Infrastructure
RTO	Research and Technology Organization
RTP	Research and Technology Project
SA	Situation Awareness
SAS	Studies, Analysis and Simulation Panel
SBA	Synthetic Based Acquisition
SE	Synthetic Environment
STEP	Scenario for Test and Evaluation Purposes
STOW	Synthetic Theatre Of War
SW	Software
TRA	Training, Rehearsal and Acquisition
UAV	Uninhabited Aerial Vehicle
UCAV	Uninhabited Combat Aerial Vehicle
USAF	United States Air Force
WEAG	Western European Armament Group
WEU	Western European Union
WRC	WEAG Research Cell